EXPERIMENTAL INVESTIGATION OF ELECTRICAL DISCHARGE MACHINING WITH COPPER AND GRAPHITE ELECTRODE

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ABSTRACT

Electrical discharge machining (EDM) is one of the earliest non-traditional machining processes. EDM is a thermal process in which rapid and continuous spark is discharged between electrically conductive work piece and electrode in dielectric medium. In the EDM process both the work piece material and the electrode material must be conductors of electricity. This process becomes cost-effective method of machining extremely tough and brittle materials. It is widely used for making molds, dies and sections of complex geometry and forming deep complex shaped holes, by arc erosion in all kinds of electro-conductive materials. The input variable parameters are current, pulse on time and duty cycle. The effect of the variable parameters mentioned above upon machining characteristics such as Material Removal Rate (MRR), Tool Wear Rate. Die sinking electrical discharge machining(EDM) is one of the most widely used techniques for the fabrication of die and mold cavities which are finally used for mass production of metals and polymer products by replication such as die casting, injection molding, etc. In any replication process, itis expected that the quality mold will faithfully duplicate its shape and surface texture. Inaccurate duplications cause problems in assemblies, operations as well as lower the aesthetic view. In die sinking EDM the electrode produces exactly its opposite shape on the work material.

Keyword: - *Optimization1, Process Parameters2, EDM3, MRR4, TWR5*

1. INTRODUCTION

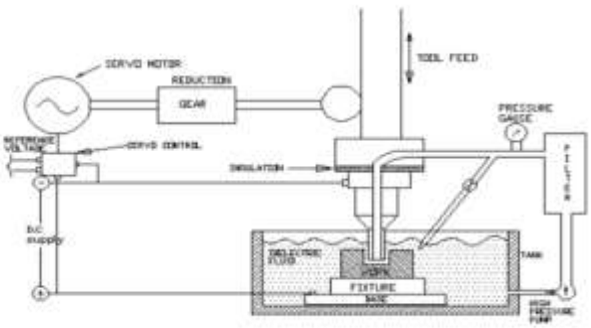
Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining Process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. EDM is mainly used to machine difficult-to-machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive.

1.1 Background of EDM

The history of EDM Machining Techniques goes as far back as the 1770s when it was discovered by an English Scientist. However, Electrical Discharge Machining was not fully taken advantage of until 1943 when Russian scientists learned how the erosive effects of the technique could be controlled and used for machining purposes. When it was originally observed by Joseph Priestly in 1770, EDM Machining was very imprecise and riddled with failures. Commercially developed in the mid-1970s, wire EDM began to be a viable technique that helped shape the metal working industry we see today. In the mid-1980s.The EDM techniques were transferred to a machine tool. This migration made EDM more widely available and appealing over traditional machining processes .EDM has been replacing drilling, milling, grinding and other traditional machining operations and is now a well-established machining option in many manufacturing industries throughout the world. And is capable of machining geometrically complex or hard material components, that are precise and difficult-to-machine such as heat treated tool steels, composites, super alloys, ceramics, carbides, heat resistant steels etc. being widely used in die and mould making industries, aerospace, aeronautics and nuclear industries. Electric Discharge Machining has also made its presence felt in the new fields such as sports, medical and surgical, instruments, optical, including automotive R&D areas.

1.2 Principal of EDM

In this process the metal is removing from the work piece due to erosion case by rapidly recurring spark discharge taking place between the tool and work piece. Show the mechanical set up and electrical set up and electrical circuit for electro discharge machining. A thin gap about 0.025mm is maintained between the tool and work piece by a servo system shown in fig 1.1 Both tool and work piece are submerged in a dielectric fluid .Kerosene/EDM oil/deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases



This fig.1.2 is shown the electric setup of the Electric discharge machining. The tool is mead cathode and work piece is anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 10 of micro seconds. And positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is just at this point when the spark jumps causing collisions between ions and electrons and creating a channel of plasma. A sudden drop of the electric resistance of the previous channel allows that current density reaches very high values producing an increase of ionization and the creation of a powerful magnetic field. The moment spark occurs sufficiently pressure developed between work and tool as a result of which a very high temperature is reached and at such high pressure and temperature that some metal is melted and eroded. Such localized extreme rise in temperature leads to material removal. Material removal occurs due to instant vaporization of the material as well as due to melting. The molten metal is not removed completely but only partially

As the potential difference is withdrawn as shown in Fig. 1.2, the plasma channel is no longer sustained. As the plasma channel collapse, it generates pressure or shock waves, which evacuates the molten material forming a crater of removed material around the site of the spark.

2. LITERTURE GAP

In EDM process, the electrode material plays vital role in material removal rate, surface finishing, electrode wear rate and machining time.. On electrode material more work should had been done before in order to reduce these outcomes. But detailed study based on types, grades and categories about graphite material haven't been done so far .Though comparative study has been done on copper. And these studies based on various literatures published so far indicates copper as best material for electrode.

That's the reason why we selected to work on graphite as a electrode material. Now-a-days most of the companies are turning towards graphite over copper due to its better results.

2.1 PROBLEM STATEMEMT

In EDM, improper selection of electrode material cause poor machining rate or performance. This is due to MRR characteristic though long machining process lesser material removal rate, it is a fertile effort unsuitable for production. The second problem is that it will decrease the accuracy of the product because of the influence of the Electrode Wear (EW) characteristic. The accuracy of the machined surface can be obtained when the EW is high or MRR is low. Furthermore, electrode wear imposes high costs on manufacturers to substitute the eroded complicated electrodes by new ones for die-making. In order to increase the machining efficiency, erosion of the work piece must be maximized and that of the electrode be minimized in EDM processes.

The important characteristics are the Material Removal Rate (MRR) and Electrode Wear rate (EW). These characteristics should be taken into account when good machining performance is needed. The experimental studies and optimization techniques of this research are to determine the MRR, EW, surface roughness (Ra)

2.2 Design of Experiments

Experiments were conducted on a die sinking EDM machine, model Mitsubishi EA-30 as shown in Figure 1(a). In this study, D2 is selected as the work material. A cylindrical electrode having 14mm diameter cooper was used as the electrode (tool). Kerosene oil was used as a dielectric.

The process parameters and their levels for the main experiments were decided on the basis of the pilot experiments conducted using one-factor-at-a-time approach.

In this study, an effort has been made to model the empirical relationship between machining parameters by using response surface methodology. The workpiece was connected to the positive polarity while the tool electrode was maintained at negative polarity. Side flushing method was employed for the dielectric fluid. A hole depth of 0.2mm for surface roughness and 1.5mm for MRR & TWR and diameter of 14mm was machined , for each run.

The process parameters and depth of cut were programmed in the NC controlled unit. Once the experimentation was completed, the workpieces were cleaned thoroughly using acetone and the final individual weight of electrode was measured. Material removal rate was calculated by using the following formula:

$$MRR = \frac{\mathrm{V(mm3)}}{t(min.)}$$

Where, $V$is volume of material removed and t is the machining time

Electrode (Tool) wear rate and MRR was calculated by using the following formula:

$$TWR = \frac{(\mathrm{Wt.\ of\ w/p\ before\ \ machining - Wt.\ of\ w/p\ after\ machining}) * 1000}{\mathrm{Density} * \mathrm{Machining\ time}}$$

2.3Design parameters –

1. Material removal rate.
2. Tool wear rate
3. Surface finishing

Machining parameter –

1. Discharge current (Ip)
2. Pulse on time (Ton)

Constant parameter-

1. Duty cycle
2. Voltage
3. Flushing pressure
4. Polarity

2.4 EDM Electrode

For this experiment we decided to select following electrode materials-

i. Copper
ii. Graphite HK-75(standard)

3. RESSULT

Weights if the specimens

Materials	Wt. Before Machining(gm)	Wt. After Machining(gm)
Copper	56.01	55.95
Graphite	42.00	41.93

Component for Cu	93.04	91.00
Component for Gr	95.00	93.04

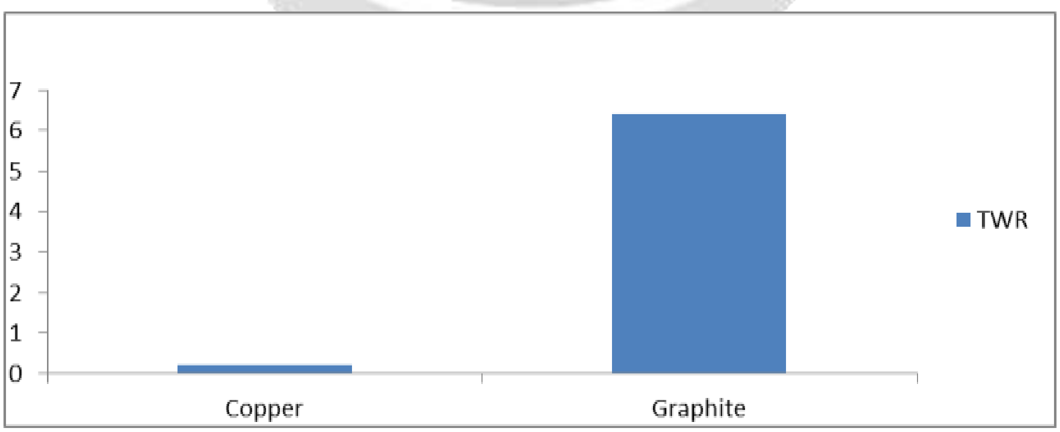
Chart -Weights of the specimens

3.1 For Electrode Wear Rate

MATERIAL	S.G	SURFACE FINISHING(Ra)	Machine time(min)
1)COPPER			
TRIAL 1ST	0.1/SIDE	1.6	15
TRAIL 2ND	0.18/SIDE	1.9	12
TRIAL 3RD	0.3/SIDE	3.2	9
2)GRAPHITE			
TRIAL 1ST	0.1/SIDE	1.6	13
TRAIL 2ND	0.18/SIDE	1.7	10
TRIAL 3RD	0.3/SIDE	2.1	8

3.2 For Electrode Wear Rate

	ELECTRODE MATERIAL	TWR
1	COPPER	$0.22 mm^3/min.$
2	GRAPHITE	$6.40 mm^3/min.$



3.3 For Material removal Rate:

	ELECTRODE MATERIAL	TWR
1	COPPER	$7.9mm^3/min$..
2	GRAPHITE	$29.28mm^3/min$.

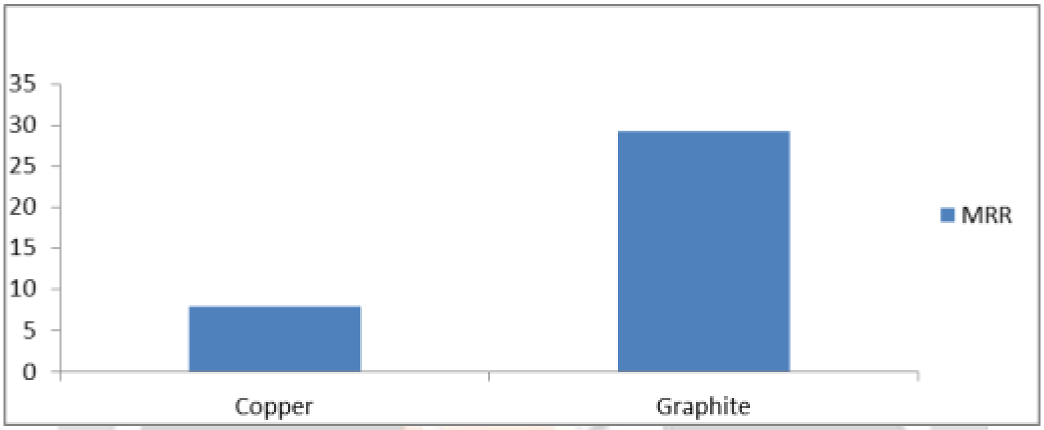


Fig -2 MRR

4. CONCLUSION

- By analyzing the theoretical research and Trial data we conclude that graphite as electrode material gives better surface finishing than copper electrode.
- When we required more surface finishing that time we have to go through graphite electrode.
- Machining time of graphite electrode is also less than copper electrode.
- If machining time required is less then we opt to choose graphite electrode as it requires less machining time as compare to the copper electrode.
- When our electrode manufacturing cost is high and electrode may require to use for longer operations then we opt to choose copper electrode as it has less electrode wear rate as compared to the graphite electrode.

5. REFERENCES

[1]. Peeyush Mishra & Dr. Lokendra Pal Singh, September, 2017. Experimental Study Of Process Parameters In Edm Using Tool Steel Electrode

[2]. Biplove Thakur , O.S. Bhatia November 2016. Experimental Analysis on Surface Roughness and Tool Wear Rate during Machining of Fabricated Al/SiCp MMC Using Electric Discharge Machining Process.

[3]. Kamalkishor G. Maniyar, Roshan V. Marode, S. B. Chikalthankar, February 2016. Optimization of EDM Process Parameters on MRR & TWR of Tungsten Carbide by Taguchi Method..

[4]. Mohan, B., Rajadurai, A. and Satyanarayana, K.G., 2002. Effect of sic and rotation of electrode on electric discharge machining of Al-sic composite. Journal of Materials Processing Technology, 124(3), 297-304.

[5]. Lin, y.-., Cheng, C.-., Su, B.-. and Hwang, L.-., 2006. Machining characteristics and optimization of machining parameters of SKH 57 high-speed steel using electrical-discharge machining based on Taguchi method. Materials and Manufacturing Processes, 21(8), 922-929.

[6]. J. Simao, H.G. Lee, D.K. Aspinwall, R.C. Dewes, and E.M. Aspinwall 2003.Workpiece surface modification using electrical discharge machining,, 43 (2003) 121–128

[7]. Singh, P.N., Raghukandan, K., Rathinasabapathi, M. And Pai, B.C., 2004. Electric discharge machining of Al-10%sicp as-cast metal matrix composites. Journal of Materials Processing Technology, 155-156(1-3), 1653-1657.
[8]. Soveja, A., Cicala, E., Grevey, D. And Jouvard, J.M., 2008. Optimisation of TA6V alloy surface laser texturing using an experimental design approach. Optics and Lasers in Engineering, 46(9), 671-678.
[9]. Yan, B.H., Wang, C.C., Chow, H.M. and Lin, Y.C., 2000. Feasibility study of rotary electrical discharge machining with ball burnishing for Al2O3/6061Al composite. International Journal of Machine Tools and Manufacture, 40(10), 1403-1421.
[10]. Yan-Cherng Lin, Yuan-feng chen, Ching-tien Lin, AND Hsinn-jyh Tzeng Feasibility study of rotary electrical discharge machining with ball burnishing for Al2O3/6061Al composite 2008, vol.23: 391–399,.
[11]. Lee, S.H. and Li, X.P., 2001. Study of the effect of machining parameters on the machining characteristics in electrical discharge machining of tungsten carbide. Journal of Materials Processing Technology, 115(3), 344-358.
[12]. Puertas, I. And Luis, C.J., 2004. A study of optimization of machining parameters for electrical discharge machining of boron carbide. Materials and Manufacturing Processes, 19(6), 1041-1070.
[13]. Wang, C.-. And Lin, Y.C., 2009. Feasibility study of electrical discharge machining for W/Cu composite. International Journal of Refractory Metals and Hard Materials, 27(5), 872-882.
[14]. Tsai, H.C., Yan, B.H. and Huang, F.Y., 2003. EDM performance of Cr/Cu-based composite electrodes. International Journal of Machine Tools and Manufacture, 43(3), 245-252.
[15]. Habib, S. S. (2009). Study of the parameters in electrical discharge machining through response surface methodology approach. Applied Mathematical Modelling, 33(12), 4397-4407.